Island Dynamics During Film Growth

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The evolution and subsequent coarsening of island structures on a surface are important for controlling the fabrication of thin films and novel nanostructures. During film growth, the initial island clusters grow or shrink (or evolve) through collecting or emitting atoms or atom clusters diffusing on the surface. Through real time microscopy we have discovered a process where islands migrate directly towards each other and coalesce into larger islands. This is a new and different pathway for island coarsening growth.

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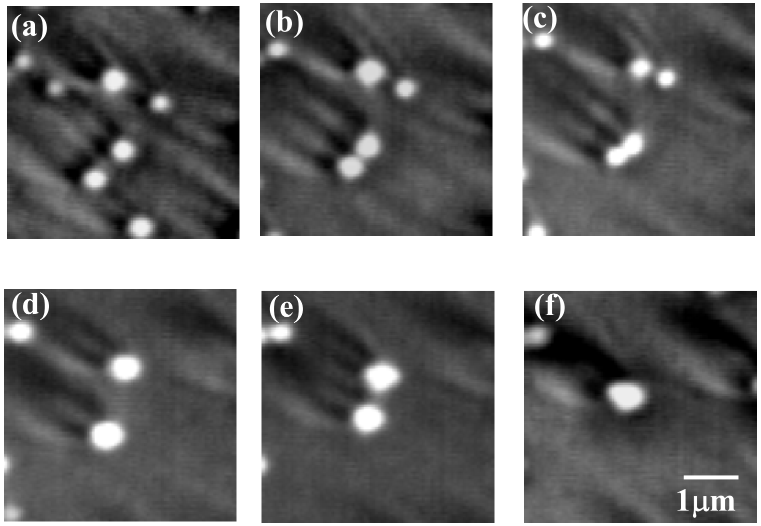

The evolution process of islands are shown in a sequence of electron emission microscopy images of $TiSi_2$ islands on a Si (111) surface during annealing at 1150^{o}C. We observe (a-c) two sets of nearby islands which migrate towards each other, and subsequently coalesce into larger islands. Then, these two coalesced islands move attractively again and coalesce into a single island (d-f).

Single Electron Effects for Nanoscale Islands on Si

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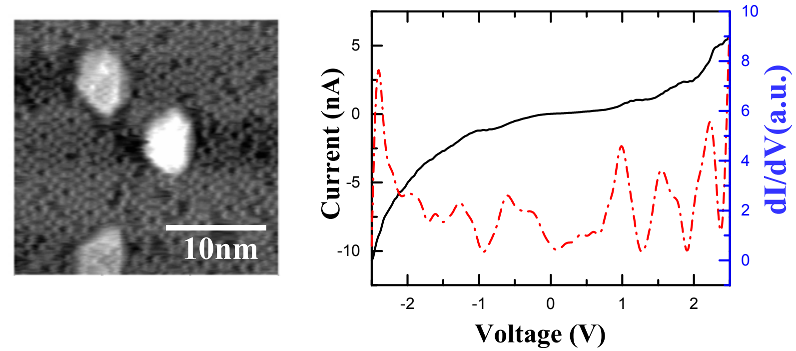
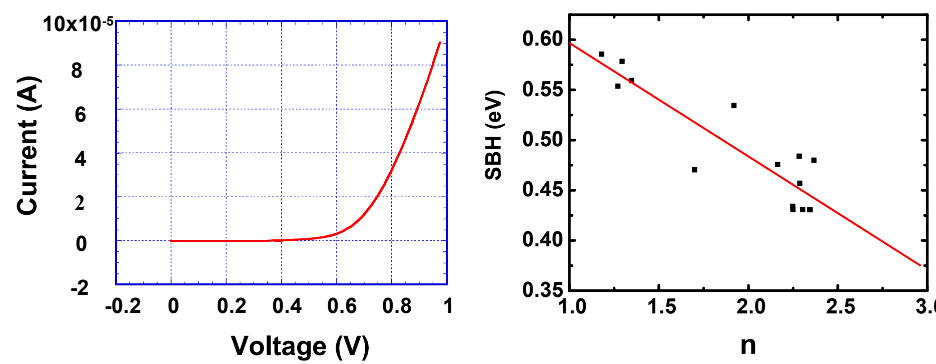
Nanoscale structures exhibit electronic properties that vary with the addition of a single electron to an isolated island. We have been able to fabricate nanoscale metallic islands on Si surfaces and characterize their electrical properties. Using scanning probe systems we found that $TiSi_2$ islands showed single electron tunneling effects at room temperature. We also deduced that the electronic properties were significantly related to the shape of the islands with a different interface barrier height from that of macroscopic diode structures.

J. Appl. Phys. 92, 3326 (2002)
J. Appl. Phys. 92, 3332 (2002)



An STM image of $TiSi_2$ islands (~5nm dia.) on a Si(111) surface, and I-V and dI/dV spectra of the island showing Coulomb blockade and staircase effects (SET effects)



AFM forward I-V from 5nm $TiSi_2$ island, and a plot of the Schottky barrier height (SBH) plotted versus ideality factor from different islands on the same Si (001) surface.

Formation of Silicide Nanowires

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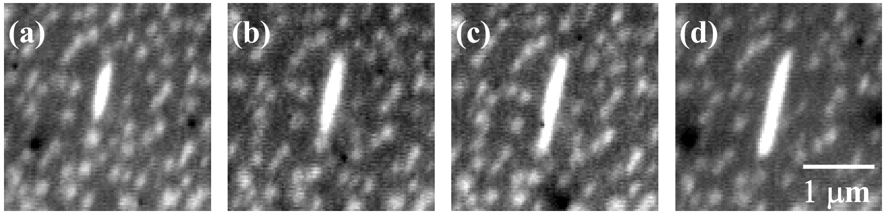
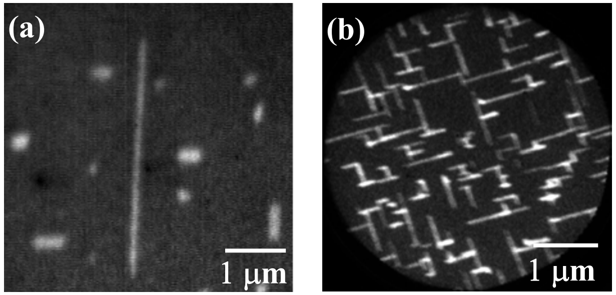
The self-assembly of nanoscale wire-like islands during epitaxial growth can be employed for the fabrication of nanowires, a basic element in a nanocircuits. Understanding of the evolution mechanisms is required for control of the nanowire dimensions. We present real time microscopy to observe the evolution of individual elongated islands. The growth conditions led to the formation of highly elongated erbium silicide and dysprosium silicide nanowires. Our analysis indicates that the self organization of the wires is related to strain relaxation at the interface of the nanowire and the Si.

J. Appl. Phys. 93, 4180 (2003)



Sequential electron emission microscopy images (~15 min) of the evolution of $ErSi_2$ wire-like islands after ~2nm Er deposition and during annealing at 800°C.



(a) $ErSi_2$ nanowires with ~ 5μm length and ~150nm width grown on Si(001)

(b) A network of $DySi_2$ nanowires with ~20nm width and ~2 μm length grown on Si(001)